REMARKS

Administrative Overview

Claims 1-25 were presented in the original Application, filed September 24, 1999. The Office action dated August 28, 2003, rejects claims 1-25 under 35 U.S.C. § 103(a).

Applicants enclose 29 pages of formal drawings, along with a Transmittal Letter, in response to the objections by the draftsperson indicated on Form PTO-948. Applicants contend that the formal drawings overcome all the objections, and Applicants request that the formal drawings be accepted by the Examiner.

The Office action rejects claims 1-21 under 35 U.S.C. § 103(a) as being unpatentable over **Yu et al. (YU)** (U.S. Patent No. 6,096,088) in view of **Kennedy (KE)** ("Flow Analysis of Injection Molds," Hanser Publishers, 1995). The Office action rejects claims 22-24 under 35 U.S.C. § 103(a) as being unpatentable over **YU** in view of **KE**, and further in view of **Haverty (HA)** (U.S. Patent No. 5,989,473). The Office action rejects claim 25 under 35 U.S.C. § 103(a) as being unpatentable over **YU** in view of **KE**, and further in view of **Talwer et al. (TA)** ("Three dimensional simulation of polymer injection molding: verification," July 1998).

Applicants hereby amend claims 1-7, 9-10, 13-14, 16-18, and 21-22, without prejudice, as shown in the preceding Listing of Claims. Support for each of the amendments may be found throughout the Specification and Drawings, and at least at the locations specified in the following table:

Claim Number	Example Locations of Support in Specification and Drawings
1	Page 20, lines 7-8 and 11-15; Page 22, lines 10-15; Page 25, lines 17-23; Page 25, line 24 to page 26, line 6; Page 26, lines 7-14; Page 19, line 28 to page 34, line 6; Figures 3, 4, 5 (items 15, 35), 10, 24 (items 190, 200), 25 (items 270, 280).
2	Page 14, lines 2-6; Equation 5.
3	Figure 24, item 210; Figure 25, item 300; Figure 2, item 80.
4	Page 14, line 5.
5	Page 14, line 5.
6	Page 20, lines 7-8 and 11-15; Page 22, lines 10-15; Page 25, lines 17-23; Page 25, line 24 to page 26, line 6; Page 26, lines 7-14; Page 19, line 28 to page 34, line 6; Figures 3, 4, 5 (items 15, 35), 10, 24 (items 190, 200), 25 (items 270, 280).
7	Page 9, line 16.
9	Page 8, line 20 to page 9, line 6.
10	Page 8, line 20 to page 9, line 6.
13	Amendment for clarity
14	Amendment for clarity
16	Page 6, lines 20-25.

17	Page 8, line 20 to page 9, line 6.
18	Page 8, line 20 to page 9, line 6.
21	Amendment for clarity
22	Page 53, lines 17-19.

Applicants hereby present new claims 26-67 for examination. Support for each of the new claims may be found throughout the Specification and Drawings, and at least at the locations specified in the following table:

Claim Number	Example Locations of Support in Specification and Drawings
26	Page 20, line 11; Page 26, lines 11-14; Figures 4 and 10B.
27	Page 20, line 11; Page 26, lines 11-14; Figures 4 and 10B.
28	Page 25, lines 17-23; Page 25, line 24 to page 26, line 6; Figure 5 (items 15, 35).
29	Page 19, line 28 to page 21, line 26; Page 19, line 28 to page 20, line 6; Figures 3, 4, and 10; Equations 7-10.
30	Page 19, line 28 to page 21, line 26; Page 19, line 28 to page 20, line 6; Figures 3, 4, and 10; Equations 7-10.
31	Page 20, lines 7-15.
32	Page 20, line 16 to page 21, line 3; Page 23, line 1 to page 24, line 10; Equations 7, 8, and 10; Figures 3, 4, and 10.
33	Page 20, line 16 to page 21, line 3; Page 23, line 1 to page 24, line 10; Equations 7, 8, and 10; Figures 3, 4, and 10.
34	Originally-filed claim 6.
35	Page 20, line 11; Page 26, lines 11-14; Figures 4 and 10B.
36	Page 20, line 11; Page 26, lines 11-14; Figures 4 and 10B.
37	Page 25, lines 17-23; Page 25, line 24 to page 26, line 6; Figure 5 (items 15, 35).
38	Page 19, line 28 to page 21, line 26; Page 19, line 28 to page 20, line 6; Figures 3, 4, and 10; Equations 7-10.
39	Page 19, line 28 to page 21, line 26; Page 19, line 28 to page 20, line 6; Figures 3, 4, and 10; Equations 7-10.
40	Page 20, lines 7-15.
41	Page 20, line 16 to page 21, line 3; Page 23, line 1 to page 24, line 10; Equations 7, 8, and 10; Figures 3, 4, and 10.
42	Page 20, line 16 to page 21, line 3; Page 23, line 1 to page 24, line 10; Equations 7, 8, and 10; Figures 3, 4, and 10.
43	Page 17, line 30 to page 18, line 7.
44	Original claim 14; Page 25, line 24 to page 26, line 6; Figure 5.
45	Page 17, line 30 to page 18, line 7.
46	Original claim 21; Page 25, line 24 to page 26, line 6; Figure 5.
47	Original claim 1; Page 26, lines 15-23; Page 25, line 24 to page 34, line 6; Figures 6, 7, 8, 9, 10A, and 10B; Equations 11-26.

48	Page 19, lines 20-22.
49	Page 19, line 28 to page 21, line 26; Page 19, line 28 to page 20, line 6; Figures 3, 4, and 10; Equations 7-10.
50	Page 22, line 16 to page 24, line 10; Equations 8 and 9.
51	Page 22, line 16 to page 24, line 10; Equations 8 and 9.
52	Page 22, line 16 to page 24, line 10; Equations 8 and 9.
53	Page 26, lines 15-23.
54	Page 24, line 17 to page 25, line 23; Page 6, lines 20-25; Page 52, lines 20-23; Equation 10.
55	Original claim 1 and 25; Page 34, line 7 to page 37, line 15; Figures 11, 12, 13A, 13B, 13C, 14A, 14B, 14C, 14D, 15A, 15B, 16, 17, 18A, and 18B.
56	Original claim 1 and 25; Page 37, line 25 to page 38, line 18; Figure 19.
57	Page 38, lines 9-12; Page 7, lines 19-22.
58	Page 41, line 10 to page 49, line 12; Table 1; Equations 35-44; Figures 20 and 21.
59	Page 49, line 13 to page 51, line 18; Figures 22, 23A, 23B, and 23C
60	Page 48, line 22 to page 49, line 12.
61	Page 50, line 5 to page 51, line 18; Figures 22, 23A, 23B, and 23C.
62	Abstract; Page 1, line 8 to page 2, line 5.
63	Page 38, line 19 to page 41, line 9; Equations 27-34.
64	Page 38, line 19 to page 41, line 9; Figure 19.
65	Page 16, lines 11-28; Original claim 1; Page 26, lines 15-23; Page 25, line 24 to page 34, line 6; Figures 1, 6, 7, 8, 9, 10A, and 10B; Equations 11-26.
66	Page 19, lines 20-22.
67	Original claim 1; Page 16, lines 11-28; Page 20, lines 7-8 and 11-15; Page 22, lines 10-15; Page 25, lines 17-23; Page 25, line 24 to page 26, line 6; page 26, lines 7-14; Page 19, line 28 to page 34, line 6; Figures 1, 3, 4, 5 (items 15, 35), 10, 24 (items 190, 200), 25 (items 270, 280).

No new matter has been added by any of these amendments or new claims. Following entry of the present Amendment, claims 1-67 are pending in this application.

Currently-Amended Independent Claim 1 Is Patentable Over the Prior Art

Claim 1 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over **YU** in view of **KE**. Applicants respectfully traverse this rejection, since, as discussed below, **YU** and **KE** fail to teach or suggest every element of claim 1 as currently amended.

Applicants amend claim 1 by removing the limitation, "determining whether at least one of the respective filling phase solutions and packing phase solutions are acceptable," and by adding the limitation, "wherein at least one of steps (d) and (e) comprises the substeps of: using a first description of a distribution of a process variable about each of a plurality of nodes or elements within the solution domain; and using a second description of the distribution of the

process variable in at least part of the solution domain comprising the plurality of nodes or elements, the second description comprising conservation of mass, conservation of momentum, and conservation of energy equations." Applicants amend steps (a), (b), (d), and (e) for clarity, in accordance with the added limitation.

Support for amended claim 1 appears in the Specification and Drawings, for example, at page 20, lines 7-8 and 11-15; page 22, lines 10-15; page 25, lines 17-23; page 25, line 24 to page 26, line 6; page 26, lines 7-14; page 19, line 28 to page 34, line 6; and Figures 3, 4, 5 (items 15, 35), 10, 24 (items 190, 200), and 25 (items 270, 280). No new matter is added.

The method of claim 1 includes novel features that allow the method to overcome problems encountered in prior art methods of modeling fluid injection in a mold. For example, claim 1 includes the novel feature of describing the distribution of a process variable, such as temperature, in at least two ways, not just one way. The method of claim 1 includes use of a first description of a process variable *about each* (not just *at* each) of a plurality of nodes or elements within the solution domain, as well as use of a *second* description of the process variable in at least part of the domain containing the plurality of nodes or elements, where the second description includes conservation of mass, momentum, and energy equations.

The Specification describes use of a first description of a process variable, for example, temperature, about each of a plurality of nodes. For example, at page 19, lines 28-29, the Specification discloses the use of a one dimensional analytic function to describe the local temperature distribution about a node, at any point in time during mold filling and packing. The Specification further discusses a second description of the process variable -- for example, a system of conservation of mass, momentum, and energy equations applied over elements of the solution domain -- that captures phenomena occurring during the filling and/or packing phases of the molding process. As described in the Specification, the two descriptions are generally not mutually exclusive. For example, the first description may be used in the second description.

The Specification at page 21, lines 6-21, explains that use of the first description, in addition to the second description, improves the accuracy of local temperature solutions. For example, during injection molding, the distribution of temperature may be highly non-linear over short time periods and over a relatively large distance. The elements of the solution domain over which governing equations are solved have shape functions which generally do not adequately describe the variation of temperature under these circumstances. The method of claim 1 enables improved description of temperature distribution because the "first description" can provide a better estimate of the local temperature distribution about a point in the mold cavity than can be provided using the linear interpolation, or even a higher order polynomial interpolation, afforded by the element shape functions. The method of claim 1 provides accurate results, while maintaining adequately low computation time.

The process variable for which the first description is used need not necessarily be temperature. For example, the Specification at page 23, lines 26-28, discusses how either

"concentration" or "temperature" can be determined using different embodiments of the invention.

Neither **YU** nor **KE** teach or suggest the use of both a first and a second description of the distribution of a process variable in a fluid injection model, as required in claim 1. For example, **YU** appears to teach a method of characterizing a solution domain for modeling flow in thin-walled objects; **YU** does not teach or suggest the use of two descriptions of a process variable in the same model. Although **KE** develops various models for flow analysis, **KE** does not teach or suggest the use of both a first and a second description of the distribution of a process variable in a given fluid injection model, as required in claim 1. There may be additional elements of claim 1 that are neither taught nor suggested by **YU** and/or **KE**. Since **YU** and **KE** fail to teach or suggest every element of amended claim 1, Applicants respectfully request that the rejection of claim 1 based on 35 U.S.C. § 103(a) be reconsidered and withdrawn.

Dependent Claims 2-5 Are Patentable Over the Prior Art

Dependent claims 2-5 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over **YU** in view of **KE**. Applicants respectfully traverse these rejections.

Since claims 2-5 depend from independent claim 1, they each include all the limitations of currently-amended claim 1. As discussed above, claim 1 is patentably distinguishable over the cited art; thus, claims 2-5 patentably distinguish over the cited art.

Since the cited art fails to teach or suggest every element of amended claims 2-5, Applicants respectfully request that the rejection of claims 2-5 based on 35 U.S.C. § 103(a) be reconsidered and withdrawn.

Currently-Amended Independent Claim 6 Is Patentable Over the Prior Art

Claim 6 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over **YU** in view of **KE**. Applicants respectfully traverse this rejection, since, as discussed below, **YU** and **KE** fail to teach or suggest every element of claim 6 as currently amended.

Applicants amend claim 6 by removing the limitation, "determining whether the respective solutions are acceptable for injection of the fluid during filling of the mold cavity," and by adding the limitation, "wherein step (d) comprises the substeps of: using a first description of a distribution of a process variable about each of a plurality of nodes or elements within the solution domain; and using a second description of the distribution of the process variable in at least part of the solution domain comprising the plurality of nodes or elements, the second description comprising conservation of mass, conservation of momentum, and conservation of energy equations." Applicants amend steps (a), (b), and (c) for clarity, in accordance with the added limitation.

Support for amended claim 6 appear in the Specification and Drawings, for example, at page 20, lines 7-8 and 11-15; page 22, lines 10-15; page 25, lines 17-23; page 25, line 24 to page 26, line 6; page 26, lines 7-14; page 19, line 28 to page 34, line 6; and Figures 3, 4, 5 (items 15, 35), 10, 24 (items 190, 200), and 25 (items 270, 280). No new matter is added.

As discussed in regard to claim 1 above, claim 6 includes novel features that allow the method to overcome problems encountered in prior art methods of modeling fluid injection in a mold. For example, claim 6 includes the novel feature of describing the distribution of a process variable, such as temperature, in at least two ways, not just one way. The method of claim 6 includes use of a first description of a process variable *about each* (not just *at* each) of a plurality of nodes or elements within the solution domain, as well as use of a *second* description of the process variable in at least part of the domain containing the plurality of nodes or elements, where the second description includes conservation of mass, momentum, and energy equations.

As discussed above, neither **YU** nor **KE** teach or suggest the use of both a first and a second description of the distribution of a process variable in a fluid injection model, as required in claim 6. Since **YU** and **KE** fail to teach or suggest every element of amended claim 1, Applicants respectfully request that the rejection of claim 6 based on 35 U.S.C. § 103(a) be reconsidered and withdrawn.

Dependent Claims 7-25 Are Patentable Over the Prior Art

Dependent claims 7-21 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over **YU** in view of **KE**. Dependent claims 22-24 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over **YU** in view of **KE**, and further in view of **HA**. Dependent claim 25 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over **YU** in view of **KE**, and further in view of **TA**. Applicants respectfully traverse these rejections.

Since claims 7-25 depend from independent claim 6, they each include all the limitations of currently-amended claim 6. None of **YU**, **KE**, **HA**, and **TA** teach or suggest the use of both a first and a second description of the distribution of a process variable in a fluid injection model, as required in claim 6. For example, **HA** appears to teach a manufacturing method for parts with porous components, and **TA** appears to teach a method of experimentally verifying simulation results. Neither **HA** nor **TA** teach or suggest the use of both a first and a second description of the distribution of a process variable in a fluid injection model. Claim 6 is patentably distinguishable over the cited art; thus, claims 7-25 patentably distinguish over the cited art.

Since the cited art fails to teach or suggest every element of amended claims 7-25, Applicants respectfully request that the rejection of claims 7-25 based on 35 U.S.C. § 103(a) be reconsidered and withdrawn.

New Claims 26-67 Are Added to More Completely Protect the Invention As Originally Described

Applicants add new claims 26-67 to further protect embodiments of the invention as originally described in the Specification and Drawings filed on September 24, 1999. Support for each of the new claims may be found throughout the Specification and Drawings, and at least at the locations specified in the table on pages 18 and 19 of this document. No new matter is added.

New Claims 26-46

Claims 26-46 depend either directly or indirectly from independent claims 1 and 6 and are patentable over the cited art at least for the reasons discussed above.

New Claims 47-67

Each of the new independent method claims 47, 55, and 56 (and claims depending therefrom) include one or more novel features that allow the method to overcome problems encountered in the prior art. Likewise, each of the new independent apparatus claims 65 and 67 (and dependent claim 66) include one or more features that are neither taught nor suggested by the prior art.

For example, limitations of conventional three dimensional injection molding modeling techniques include those relating to the large temperature gradients, the movement of the solid/liquid interface boundary, the large material property variations during solidification, and the solidification of melt material during molding. Claims 47-67 are drawn to methods that address these limitations.

Independent claim 47 is drawn to a method of modeling injection of a fluid into a mold that overcomes limitations of prior techniques by including use of an explicit scheme in solving the conservation of energy equation. For example, the Specification presents an explicit temperature convection scheme using a one-dimensional analytic function to overcome prior art limitations relating to inadequate modeling of large temperature gradients.

Independent claim 55 is drawn to a method of modeling injection of a fluid into a mold that includes the step of anisotropically refining the mesh by calculating a distance from a node to a boundary and by using a node layer numbering system. The method overcomes limitations of prior techniques by allowing a means of increasing resolution in a mold cavity without an unnecessary increase in computational burden due to over-refinement.

Independent claim 56 is drawn to a method of modeling injection of a fluid into a mold that includes the step of determining a location of a solid/liquid interface by determining locations at which a process variable achieves a given value, for example, a solidification temperature. In one embodiment, the method overcomes limitations of prior techniques related to the large material property variations that occur during solidification by employing a one dimensional analytic function to model temperature distribution about a point. Claims

depending from claim 56 present additional novel steps performed in various embodiments of the method.

Independent claim 65 is an apparatus claim based on the method of claim 47, and independent claim 67 is an apparatus claim based on the method of claim 1.

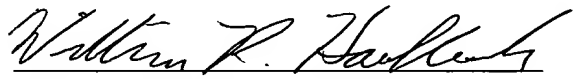
Applicants submit that new claims 26-67 are in condition for allowance.

Conclusion

Applicants request that the Examiner reconsider the Application and claims in light of the foregoing Amendment and Response. Applicants respectfully submit that in view of the amendments and remarks herein, all of claims 1-67 are in condition for allowance.

If the Examiner believes that it would be helpful to discuss any aspect of the Application by telephone, the undersigned representative cordially invites the Examiner to call at the telephone number given below.

Respectfully submitted,



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William R. Haulbrook, Ph.D.
Attorney for Applicants
Testa, Hurwitz, & Thibeault, LLP
125 High Street
Boston, Massachusetts 02110

Tel. No.: (617) 310-8427
Fax No.: (617) 248-7100

2705843_1